

vided. The pillars ensure precise positioning of the lid holder and the substrate holder when the lid holder is placed on the substrate holder. Other types of mechanical guides are also useful.

In one embodiment of the invention, mechanical guides are used to keep the substrate in the correct position. In FIG. 3, a cavity 320 is provided to hold and align the substrate. Alternatively, the substrate can be kept from moving out of position by a vacuum chuck. In another embodiment, an adhesive tape that loses its adhesion after some treatment (e.g. heat exposure or UV radiation) is used.

FIG. 4 shows a cover lid holder 400 that is used to place the thin flexible lid on the substrate. Alignment guides 440 are provided to align the lid holder with the substrate holder. In one embodiment of the invention, a glass support 420 that is transparent to UV radiation is used to cover the lid so that UV light can permeate and cure the UV-curable sealant during the sealing process. The areas where the sensitive OLEDs are located are shielded from the radiation. In another embodiment, the lid cover holder contains an ultraviolet lamp 480 for curing the UV-curable sealant. In yet another embodiment of the invention, the cover lid holder contains an infrared lamp 470 for curing a thermal-curable sealant. Alternatively, if thermal-curable sealant is used, the area above the sealant region is made transparent to infrared radiation to allow the radiation to pass through and cure the sealant.

In a preferred embodiment of the invention, a special adhesive release tape 430 that loses its adhesive property after a treatment process, such as heat exposure or UV radiation, is used to keep the lid from moving out of place. The tape can have adhesive coating either on one side or on both sides. In one embodiment, the adhesive tape is fixed to a tool, which attaches the tape to the lid. In yet another embodiment, a vacuum chuck is used to keep the lid in place.

FIGS. 5-8 show a process for encapsulating the OLED device in accordance with one embodiment of the invention. Referring to FIG. 5, the thin flexible lid 220 is attached to the lid holder 510 using adhesive release tape 430. As shown, the lid holder comprises a surface area which is greater than the lid. The surface of the lid holder on which the lid is placed should show low adhesion to the sealant 230 used (e.g. epoxy resin). This is to ensure that the substrate with the lid can easily be removed from the lid holder after applying and curing the sealant. If any adhesive tape is used to attach the lid to the holder, it should also show low adhesion to the adhesive tape. Alternatively, a vacuum chuck 506 is used to keep the lid in place.

In one embodiment of the invention shown in FIG. 6, the substrate 240 containing the OLED is positioned on the substrate holder 300. As shown, the substrate holder comprises a surface area which is greater than the substrate. The substrate on the substrate holder should be held in place by a vacuum chuck 606, adhesive release tape 607 or mechanical guides.

The rim of the substrate, which is the sealing region, has to be clean before the lid is placed on the substrate. In one embodiment, the substrate undergoes a cleaning treatment along the rim. Cleaning methods include laser cleaning, wet chemical treatment, dry cleaning, mechanical treatment or a combination of all these methods. In another embodiment, the sealing region is protected by masking before or during the sealing procedure.

Referring to FIG. 7, the cover lid holder 400 containing the thin flexible lid is aligned with the substrate holder 300

containing the substrate. In one embodiment of the invention, the substrate holder and lid holder contain mechanical guides to ensure precise positioning of the lid holder with respect to the substrate holder. In one embodiment, the substrate holder is positioned on top of the lid holder. Alternatively, the lid holder is positioned on top of the substrate holder.

In one embodiment of the invention, the sealant 230 is dispensed onto the lid before mounting the lid onto the substrate. Alternatively, the sealant is dispensed onto the substrate before mounting. In yet another embodiment, the sealant is dispensed onto the substrate after placing the lid onto the substrate.

After dispensing the sealant, the lid holder and the substrate holder are pressed together to ensure good contact of the lid cover with the substrate. In one embodiment of the invention, the sealant is cured using UV radiation, thus hermetically sealing the OLED device. Alternatively, infrared radiation, heat treatment or a combination of these treatments can be applied to cure the sealant.

If the adhesive tape that is used to attach the substrate or lid to the holders has not lost its adhesion after curing the sealant, the apparatus is placed either on a hot plate, if heat release tape is used, or under a UV lamp, for UV release tape. Alternatively, if other types of special adhesive tape are used, the apparatus is subjected to the treatment that makes the tape lose its adhesive property.

After the treatment, the substrate holder and cover lid holder are separated and the encapsulated device is safely taken out, as shown in FIG. 8, without breaking the lid or the substrate. The present invention is not limited to the processing of a single unit. For example, multiple units which are formed on a single large substrate can be encapsulated in parallel and subsequently separated into individual units. Application of the invention is not limited to a single unit. It is also possible to encapsulate the units before singulation while they are still combined on the mother glass.

EXAMPLE

The OLED is prepared on a thin flexible substrate (50 μm thick, 50 mm \times 50 mm) using conventional techniques. The substrate is placed on the substrate holder. A flexible cover lid for sealing is attached to the lid holder using heat release tape from Nitto Denko. The flexible lid is 50 μm thick and has dimensions 22 mm by 22 mm. Epoxy resin is dispensed along the perimeter of the lid for sealing. The cover lid is placed onto the substrate by placing the lid holder on top of the substrate holder, positioned by mechanical guides on the substrate and lid holders. An ultraviolet lamp is used to cure the epoxy sealant. The apparatus is then placed on a hotplate at 130 degrees Celsius for 1 minute. The heat release tape loses its adhesion and safely releases the encapsulated OLED device onto the substrate holder.

While the invention has been particularly shown and described with reference to various embodiments, it will be recognized by those skilled in the art that modifications and changes may be made to the present invention without departing from the spirit and scope thereof. The scope of the invention should therefore be determined not with reference to the above description but with reference to the appended claims along with their full scope of equivalents.

What is claimed is:

1. A method for encapsulating a device comprising:

mounting a substrate on a substrate holder, the substrate includes a device region and a sealing region surrounding the device region;